A Summary of Biological Monitoring of the New Fork River in the Pinedale Anticline Project Area: 2010

An Assessment of Spatial and Temporal Changes in Macroinvertebrate Community Structure

Background

Macroinvertebrates (aquatic insects and similar animals) are important indicators of ecosystem health. They respond rapidly to disturbances; usually responding with changes in community structure before fish populations show reductions in biomass production or survival. They also allow the sources of disturbances to be pin-pointed because they have relatively limited mobility. Furthermore, macroinvertebrates are very important in processing of organic matter in aquatic ecosystems; they facilitate the availability of organic matter to fish. In short, there would be no fish without macroinvertebrates (e.g., Wilson 1991).

The use of aquatic insect communities to evaluate the effects of anthropogenic activities has a long history in the United States. Beginning in the 1940's the effects of sewage, industrial effluents, and nuclear cooling discharge have all described using changes in the abundance of different types of aquatic insects. Since this time, many methods have developed to use aquatic invertebrates to describe ecological shifts caused by pollution and alteration of natural ecosystems. Our approach has been to use measures that summarize the abundance of different kinds of invertebrates in terms of their roles in river food webs and their tolerance to different kinds of disturbances. These measures are called biological metrics and they will be discussed further in the results section of this summary.

The monitoring program has changed overtime to adjust for increased development in the PAPA and to account for natural changes in the river. The program began by using sites several sites from the Sublette County Conservation District's surface water monitoring program, which were augmented by two sites (NF30 NF40) which were believed by the district to be upstream (NF40) and downstream (NF30) of all direct influences of development in the PAPA; including activities at the Anticline Disposal site.

Over time, it became apparent that some of SCCD's surface water monitoring sites did not provide ideal comparisons for lower New Fork River sites. Additionally, the sampling program was expanded to include measurements of micro-scale habitat measures to expand the explanatory power of the monitoring program. The purpose of this document is to summarize the results of the 2011 monitoring program and to briefly review the results from previous years.

Previous Findings

In 2005, the monitoring program found elevated abundance of small worms at NF30 especially compared to NF40 and other upstream sites. Worms in and of themselves are not necessarily detrimental to river ecosystems, but they are usually a minor component of the community (about >5%). However, SCCD's baseline monitoring of streams in the lower lands of Sublette County suggests that background densities of small worms (*Nais* sp. (pronounced : "Nice")) are often somewhat higher than many other areas; Here we expect values to be less than about 15% of the community. Since this time the abundances of worms at NF30 were above the SCCD's baseline expectations of 15%.

In 2008, we found that the abundance of small worms comprised an average relative abundance of about ~28% of the community at NF30 and about 8% at NF40, with one sample from NF30 had 55% of the community comprised of worms. This amounted to about 10,000 individuals / m^2. Additionally, we found that the metrics that were responsive to high worm abundance were highly correlated with finer sediments. This was not surprising because these worms are known to inhabit the interstitial spaces among finer sediments. We also found that the abundance of fine sediments in randomly placed samples were correlated with high water velocity only at NF30 (typically, finer sediments accumulate in slower waters), indicating active erosion processes near NF30 only. The multivariate[1] analyses (complicated statistics which examine the abundance of all species simultaneously) indicated that the abundance of worms was strongly correlated with fine sediment and was strong indicator of the overall community composition.

These results were accompanied with observations of much natural gas development activity in riparian areas and on river banks. Erosion controls had also failed at many riverside platforms, as observed in 2009, when the 2008 report was presented to the PAWG. However, sedimentation was very likely exacerbated by several years of below average runoff in the spring. Spring runoff is a very important mechanism for maintaining healthy stream channels in the western USA. We anticipated that an average sustained flow (or above average sustained flow) in the spring would restore the river to normal conditions.

2009's monitoring program (Marshall 2010) found that the first year with high sustained flows resulted in a dramatic improvement of most metrics, overall community structure, and reduction in the abundance of worms. The abundance of non-insects (mostly worms) was only about 7% on average at NF30, and about 9% at NF40. These observations were within the margin of error for the study and the means of both assemblages were well within the bounds of the 95% confidence interval.

[1] Multivariate Analyses included Principle Components Analysis (PCA), Detrended Correspondence Analysis (DCA), Canonical Correspondence Analysis (CCA), and Nonmetric multidimensional Dimensional Scaling (NMDS).

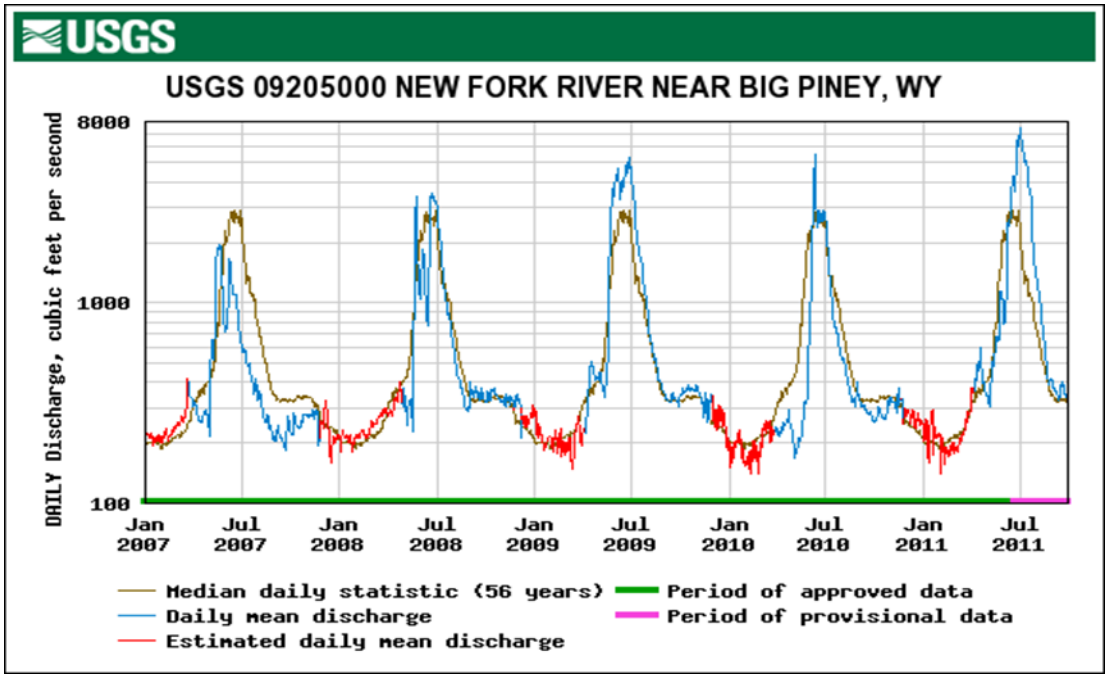
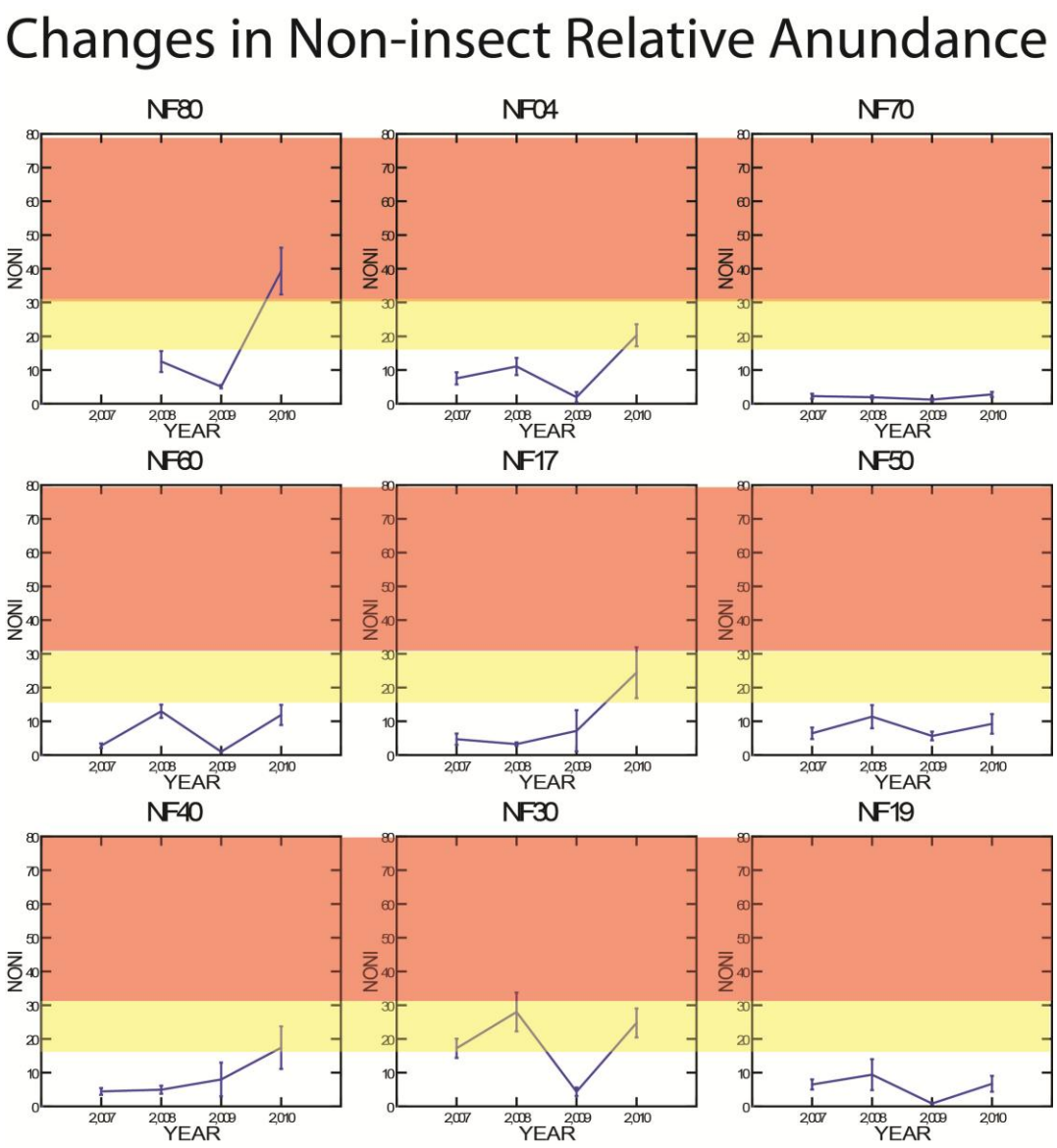


FIGURE 1. New Fork River Daily Discharge. The figure shows the median average daily discharge of the New Fork River near Big Piney, WY in cubic feet per second (cfs). Notice that the scale is logarithmic so that the increase from 100-1000 displays the same amount of vertical change as 1000-10,000 cfs (although the scale is truncated at 8000 cfs). Thus, one increment on the Y-Axis below 1000 cfs represents a change of 100cfs, and one increment on the same axis between 1000 and 10,000 cfs represents a 1000 cfs change. The discharge of the Few Fork River was well below the 56 year median value before 2009. The spring 2009 runoff event was the first sustained discharge above the long-term median value. The current report deals with the 2010 sampling season which had average discharge magnitude, but the volume was not sustained for the typical duration.

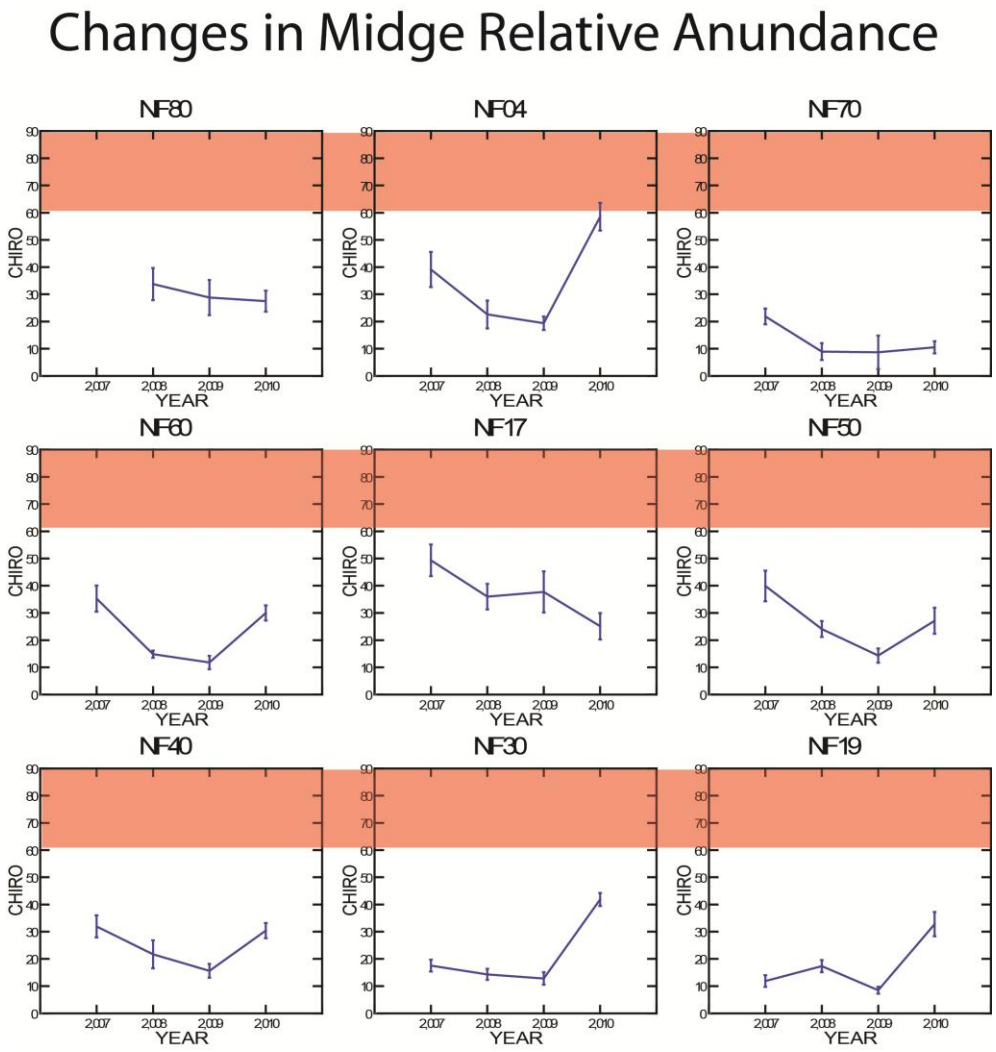
2010 Monitoring Results

Most macroinvertebrate community indicators indicated that 2009 was either an improvement or not significantly different from 2008. This differs from the observations of 2010, where most sites exhibited a statistically significant decline in most metrics used to describe the condition of aquatic insect assemblages. Specifically, NF80, an upstream reference site from 2008-2009 had a dramatic increase in the abundance of non-insects (mostly *Nais* worms) from about 5% to about 40% on average. NF04 increased from >5% to about 20%. Non-insect abundances of the sites NF70, NF50 and NF19 did not change significantly from 2009. Most remaining sites had a statistically significant increase in the relative abundance of non-insects in 2010. These changes affected all the other metrics (see figure below).

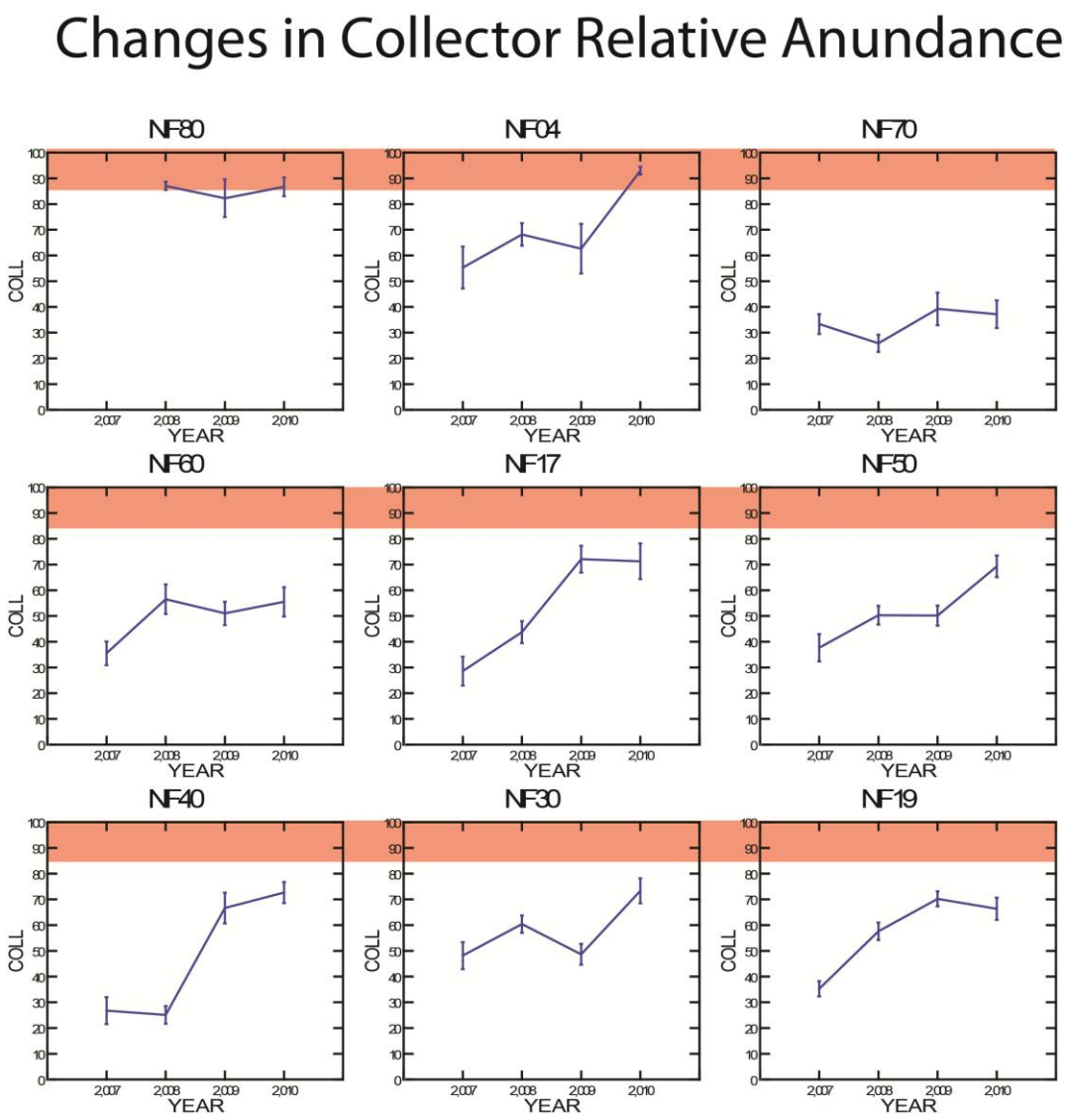


The abundance of Chironomid midges also increased at many sites. Midges and non-insects tend to become more prevalent in stream communities when other types of insects (such as mayflies, stoneflies and caddisflies) become less successful. This often happens in situations where organic enrichment or sedimentation becomes a problem. The reddish highlight shows midge abundance >60% which is a threshold in coastal rivers which are dominated by fine sediments. We have found that the abundance of midges can be quite variable in the New Fork River and Green River, Some locations consistently have communities that are <25% chironomid midges, whereas others, with more plant growth or sand often have ~50% midge dominance. The threshold of >60% was used to remind readers that high values of this metric are not desired and values in excess are exceptional—and could warrant concern.

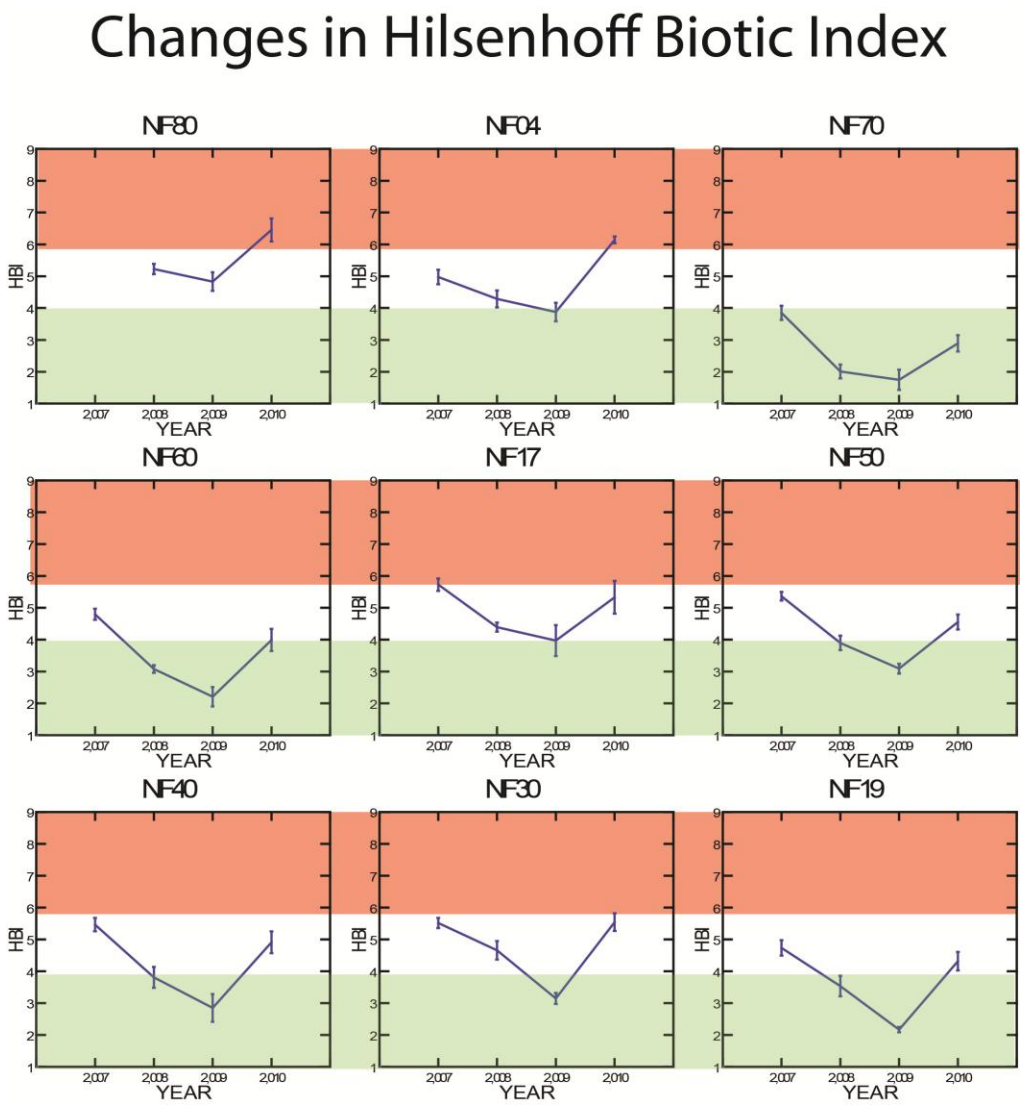
.



As mentioned in the introduction, we often group invertebrates by their roles in processing organic matter in river food webs. When midges are considered collectively, they are assigned to the group known as “collectors.” Collectors are organisms that consume fine particles of organic detritus. They are generally not particular of the source of organic material. An earlier study by Stribling et al. (2000) found that collectors should comprise less than about 85% of the community in Wyoming Basin streams and rivers. In surveys of urban streams, I have found collectors comprise >95% of the assemblage. The abundance-of-collectors exhibits a disconcerting trend of increasing abundance at most sites since the beginning of the program.

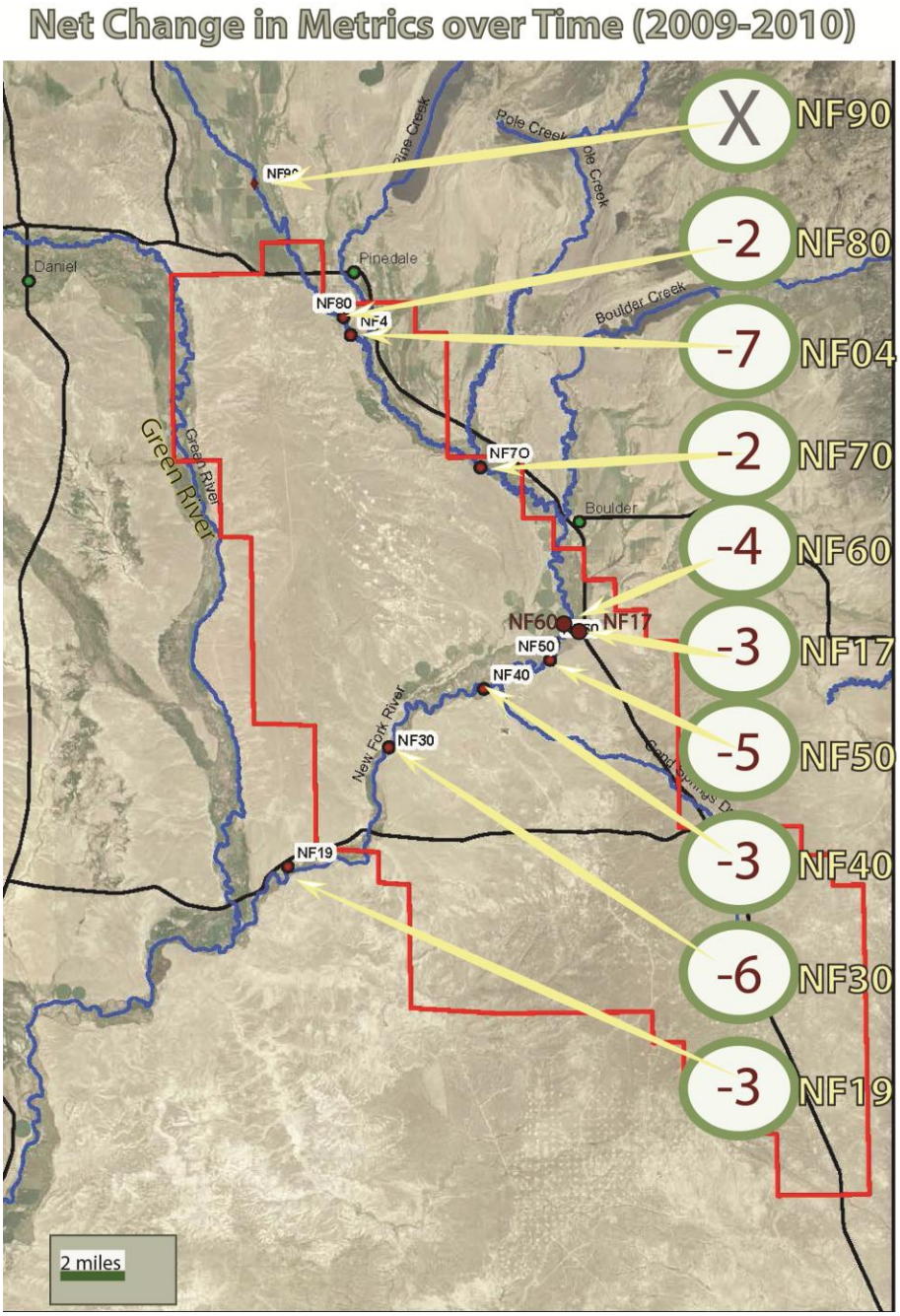


The Hilsenhoff Biotic Index (HBI) estimates the average tolerance of all invertebrate species to organic pollution on a scale of 0-10, increasing with average tolerance to pollution. Thus a score of zero would only occur where all the species occurring were very sensitive to organic pollution and a value around 10 should only occur in sewage lagoons. The idea is that greater abundances of sensitive organisms indicate conditions of low-enrichment and high oxygen. The metric is also responsive to sedimentation. Most sites showed an increase in 2010 HBI values. A few sites even had HBI values >6, indicating a large number of tolerant organisms.

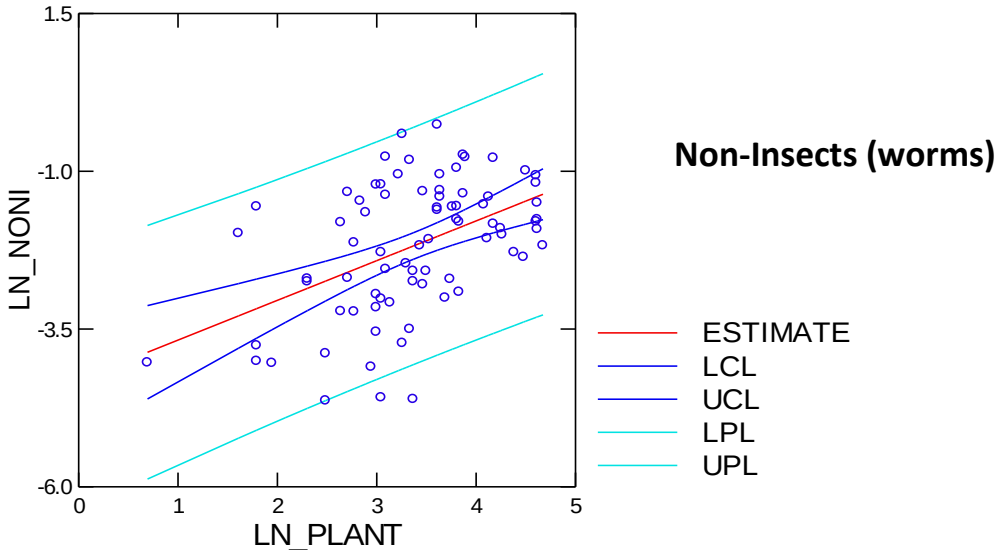


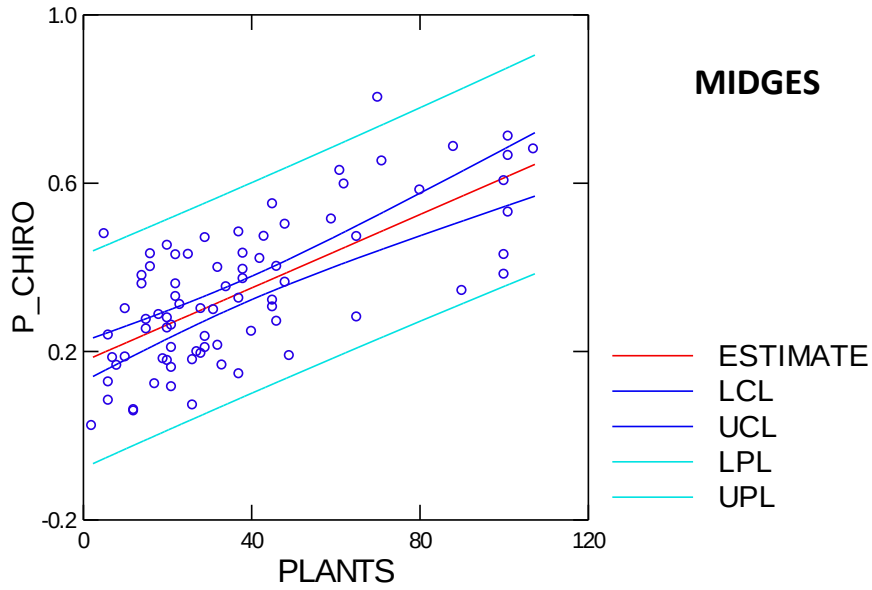
Summary

Since 2009 was the year of great improvement in the condition of macroinvertebrate assemblages of the New Fork River, we expected that with the reduced flows in 2010 might result in a slight decline in several macroinvertebrate water quality indicators. However, the changes from the previous year were more dramatic than expected. One of the sites in the upper study area, NF04, exhibited statistically significant declines in all 7 metric used to describe the community structure. NF30, the site which we were traditionally concerned about the accumulations of sediment below riverside development work, had statistically significant declines in 6/7 metrics. The prevalence of these conditions was more than anticipated.



We analyzed the covariates collected with each sample and found that the metrics were more strongly correlated with estimates of plant cover in the sample area than they were with fine sediments. We do not know of any reason for development on the PAPA to increase the growth of plants, but do we know that a nuisance alga occurs in the area; it can greatly reduce the success of other insects, while enhancing the production of worms and midges. During the laboratory work we found algae cells in the stomachs of midge larvae. We recommend that the type and amount of plant material be documented to ensure that operators are not blamed for changes that could be related to algae.





Conclusions

- The biological condition of the New Fork River appears to have declined in 2010 relative to 2009.
- The decline in condition was related to increases in the relative abundance of midges and worms.
- A small decline in condition was expected because 2009 was a very good year for river flows.
- The decline in condition was greater than expected.
- The abundances of tolerant groups (midges and worms) were correlated with a crude estimate of plant cover.
- Observations in the field and laboratory indicate that the nuisance alga *Didymosphenia geminata* occurred at several sites in the study area.
- We recommend a quantitative algae sampling be added to the field work at a small cost to increase the diagnostic power of the assessment. This is important to ensure that PAPA development is not assumed to have caused degradation of the New Fork River, which may be related to other factors.
- This will add about $25 per sample.
- The figure below shows some indicators of community response where this algae is present. Notice that the abundance of "good bugs" approaches zero above 8 mg/cm of algae.